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F1V
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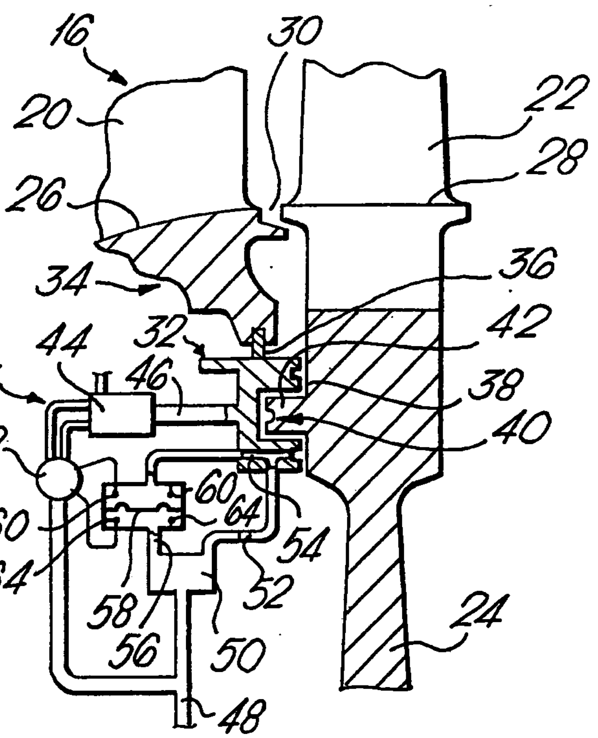
## (54) Gas turbine floating seal

(57) Leakage of gases through the gap 30 between stator 20 and rotor 22, is prevented by the supply of high pressure air to the space radially inwardly of an annular seal 32 which forms a serpentine airflow path with the rotor disc 24. Relative axial movement of disc 24 and seal 32 is nullified by high pressure air being fed onto the disc face from the seal face to create a back pressure which is fed to a signal generating device 43, change in back pressure causing mechanism 44 to move the seal 32 into proper positional relationship with the disc 24.

Fig. 2.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig.1.

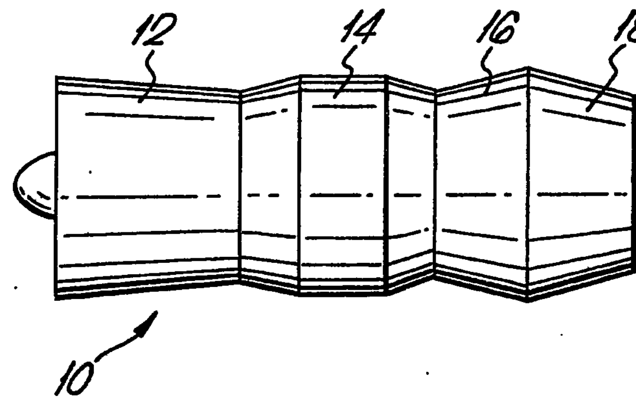
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Fig.2.

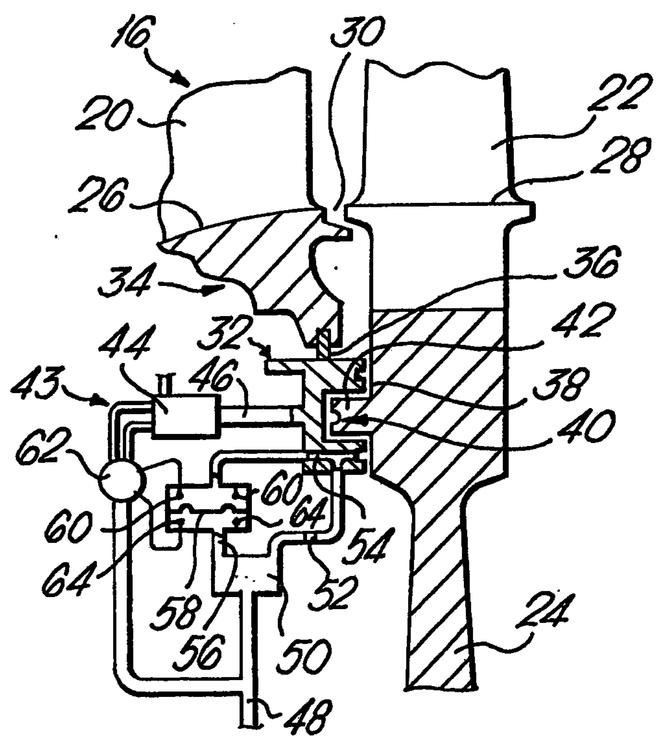
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Fig. 3.

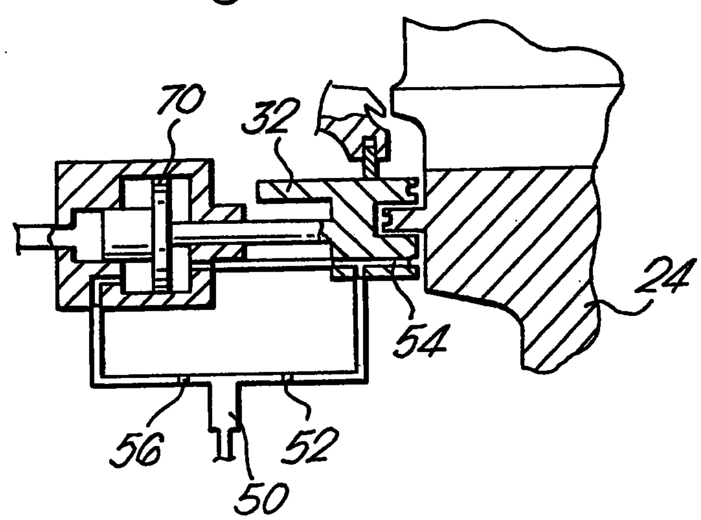
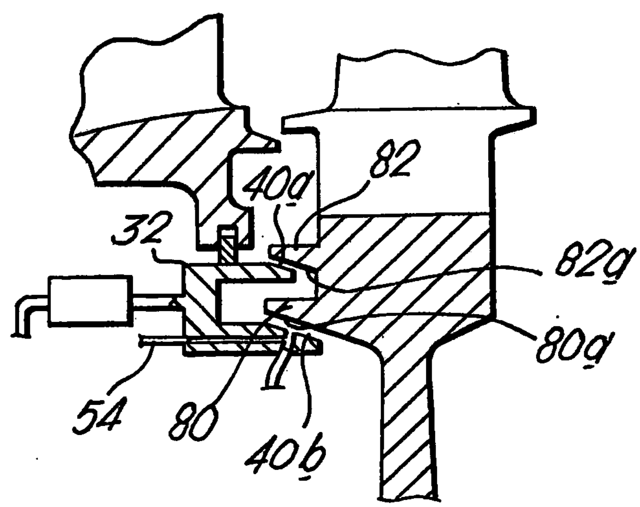



Fig. 4.



SPECIFICATION

**Fluid seal**

This invention relates to a seal which is required to operate in a gas turbine engine. More specifically the seal is required to operate at the interface of hot and cold fluid flows, at positions between static and rotating members.

Gas turbine engine turbine discs rotate next to fixed stator structure. In order to prevent turbine gases leaking from the turbine gas annulus, radially inwards onto the disc face, air from the compressor is directed to the area of the disc near its rim and a seal structure is provided and arranged, so that air may leak in controlled manner radially outwards across the seal, into the gas annulus.

Axial loads and differential expansions in shafts and casings, cause *inter alia* the positions of turbine and compressor rotors to vary, depending on engine throttle settings. It follows, that the clearances between seal and turbine and compressor structure will vary and so result in a falling off of seal efficiency, unless some provision is made for the seal to move in compensatory manner.

The present invention seeks to provide a gas turbine engine including improved, movable seal structure.

According to the present invention, a gas turbine engine includes a rotor, the disc of which has an annular land in an upstream, face, an annular seal slidably mounted in fixed structure adjacent to the disc and having a grooved face which with the disc land, provides a serpentine fluid flow path in a direction generally radially of the disc, a proximity sensor in the seal for sensing the proximity of its grooved face to the disc, and adapted so as to bring about sliding movement of the seal towards or away from the disc, in accordance with the sensed proximity of seal to disc.

Preferably, the sensor comprises a passage in the seal, connected to receive pressurized fluid from a source external to the seal and exiting from the seal face onto a portion of the disc, in a direction normal thereto, such that variation in proximity of seal to disc, results in variation in back pressure in the passage.

The adaptation may include leading the passage to signal means connected to moving means to bring about movement of the seal relative to the disc, which means is subject to further pressure in opposition to back pressure.

The signal means may comprise a diaphragm movable between electrical contacts to make electrical circuits with which to drive a power means connected to move the seal.

Alternatively, the means may comprise a piston in a cylinder, the piston being connected to move the seal and the cylinder being connected to receive the back pressure at a point on one side of the piston and supply pressure on the other side thereof.

Preferably the seal includes a pair of annular lands which together, form the face, the two lands in operation being positioned so as to straddle the land on the upstream face of the disc in coaxial manner.

The disc upstream face may comprise two annular lands, one of which is straddled by the lands on the seal in coaxial manner.

The disc portion may be a land upon which fluid pressure impinges as its exits from the passage, in a direction normal to the land.

The invention will now be described, by way of example and with reference to the accompanying drawings in which:

The disc may be a turbine disc.

Alternately the disc may be the ultimate downstream compressor disc in a row of compressor discs.

The invention will now be described, by way of example and with reference to the accompanying drawings in which:

Fig. 1 is a diagrammatic sketch of a gas turbine engine.

Fig. 2 is an enlarged part view of the gas turbine engine of Fig. 1 and including an embodiment of the invention and

Fig. 3 and 4 are views corresponding to Fig. 2, but depicting alternative embodiments of the invention.

In Fig. 1 a gas turbine engine 10 comprises a compressor 12, combustion equipment 14, a turbine section 16 and an exhaust nozzle 18, all in flow series.

Referring to Fig. 2. Turbine section 16 includes at least one stage of static guide vanes 20 and one stage of rotary turbine blades 22 mounted on a turbine disc 24.

The platforms 26 of guide vanes 20 and platforms 28 of turbine blades 22, together form the inner wall of an annular gas flow duct. However, because guide vanes 20 and the turbine stage of blades 22 and disc 24, are relatively rotatable, a gap 30 must be provided between platforms 26 and 28. It follows that, if preventive measures are not taken, hot gases will leak through gap 30 and in so doing, will overheat the structure radially inwardly of gap 30, as well as reduce turbine efficiency.

In the present example, air is bled from a point in the compressor 12 (Fig. 1) which ensures that the air so bled, is at a higher pressure than the turbine gases. The air is taken to the space adjacent the turbine disc 24, where it is leaked radially outwards past an annular seal 32, in a manner to be described hereinafter.

Annular seal 32 is supported for axial sliding movement, in the radially inner portion 34 of the stage of guide vanes 20. The provision of a piston ring seal 36 enables such movement, without detriment to the efficiency of seal 32.

The downstream face 38 of seal 32, has a groove 40 therein, which straddles a land 42 on the upstream face of disc 24, in spaced relationship. There is thus provided a serpentine path for the pressurized air to pass through, in a direction generally radially outwardly of disc 24.

During operation of the gas turbine engine 10, it is important to maintain the clearance between seal 32 and the adjacent portion of turbine disc 24 within certain limits. The turbine disc 24 however, moves axially under the gas loads imposed on it *via* the turbine blades 22 and also relative expansion. Seal 32 is therefore provided with an adjusting device 43, which constantly adjusts the position of seal 32 with respect to disc 24, by amounts identical with the magnitude of movement of disc 24.

Device 43, in one embodiment of the invention, is a reversible air motor 44, connected *via* a screw 46, to seal 32. Air under pressure is fed *via* a conduit 48, to a plenum chamber 50 from where it divides and passes on the one hand, through a restrictor 52 to a passage 54 in seal 32, which exits against the upstream face of turbine 24 and, on the other hand, through another restrictor 56, to one side of a flexible diaphragm 58.

Passage 54 also extends through seal 32, to communicate with the other side of diaphragm 58. It follows that the air further divides, some exiting onto the face of disc 24, the remainder to the diaphragm 58 in opposition to the air acting on the one side thereof.

The gas turbine engine 10 described herein, is of the kind utilised for the propulsion of an aircraft.

The spacing of seal 32 with respect to the land 42 is arranged such that during cruise of an associated aircraft, sufficient pressurized air leaks through the serpentine path, in a direction generally radially outwards of turbine disc 24, as to prevent leakage of hot gases radially inwards, through gap 30.

If however, the throttle of engine 10 is opened as for take off, or partially closed as for landing, the changed operating conditions in turbine section 16, will result in variation of that spacing. The variation is temporary. The reduction in back pressure which results from disc 24 moving away from the exit of passage 54 when the throttle is opened causes diaphragm 58 to flex upwardly and bridge electrical contacts 60. An electrical circuit is closed and brings about actuation of a valve 62, whereupon pressurized air is fed to air motor 44 in such a way, as to cause screw 46 to rotate and push seal 32 downstream, after turbine disc 24.

When seal 32 reaches a position adjacent disc 24, which corresponds to its first position, this will be indicated by back pressure re-building in passage 54. As a result, the diaphragm 58 will return to its position intermediate electrical contacts 60 and other electrical contacts 64, thus removing the air drive from screw 46.

Should disc 24 move upstream from its cruise position, back pressure in passage 54 will increase and diaphragm 58 will flex downwards, bridging electrical contacts 64. Air will then drive air motor in a reverse direction to that described earlier in this specification, and cause screw 46 to pull seal 32 upstream, so as to maintain cruise clearance with disc 24.

Referring now to Fig. 3 which is a further embodiment of the invention in which like parts have been given like numbers.

Seal 32 is maintained in a given position with respect to disc 24, again by the utilization of back pressure in passage 54. In the arrangement of Fig. 3 however, pressurized air from plenum chamber 50 is passed through restrictor 56 to one side of a piston 70 and through a restrictor 52 to passage 54, which at one end exits into the face of disc 24 and at the other end, onto the other face of piston 70. Variation in spacing between seal 32 and disc 24, bring about appropriate movement of piston 70 which, being connected to seal 32 also moves the latter.

In Fig. 4 a further embodiment of the invention includes a turbine disc 24 which has two lands 80, 82. The groove portion 40 of seal 32 has chamfered surfaces 40*a*, 40*b* which cooperate with correspondingly chamfered portions 80*a*, 80*b* on lands 80, 82.

The mechanism for moving seal 32 with respect to disc 24 is the same as is utilised in Fig. 2 or in Fig. 3 and so will not be described. However, the signals by which the mechanism is operated, is as in Fig. 2 or Fig. 3 i.e. change in back pressure in passage 54, resulting from changes in the position of disc 24 relative to seal 32.

The invention has equal efficacy, in the sealing of the downstream disc of a compressor, so as to prevent leaks inwardly of compressed air, at the interface of compressor exit and diffuser intake. The arrangement would differ from that described herein, only by way of applying the seal and seal features to the downstream face of the compressor rotor disc (not shown).

**Claims**

1. A gas turbine engine including a rotor, the disc of which has an annular land on a face, an annular seal slidably mounted in fixed structure adjacent to the disc and having a grooved face which with the disc land, provides a serpentine flow path in a direction generally radially of the disc, a proximity sensor in the seal for sensing the proximity of its grooved face to the disc, and adapted so as to bring about sliding movement of the seal towards and away from the disc, in accordance with the sensed proximity of seal to disc.

2. A gas turbine engine as claimed in claim 1 wherein said seal includes a passage connected to an external pressurized fluid supply and having an exit adjacent and onto the upstream face of said disc in a direction normal thereto, such that in operation, variation in proximity of seal to disc results in variation in back pressure in said passage.

3. A gas turbine engine as claimed in claim 2 wherein the adaptations includes leading said passage to signal means connected to moving means to bring about movement of said seal relative to said disc, which signal means is subject

to further pressure in opposition to said back pressure.

4. A gas turbine engine as claimed in claim 3 wherein the signal means comprises a flexible diaphragm, movable between electrical contacts to make electrical circuit with which to drive a power means which is connected to move said seal.

5. A gas turbine engine as claimed in claim 2 wherein said adaptation comprises leading said passage to communicate with one side of a piston which is connected to move said seal and exposing the other side of said piston to further fluid pressure in opposition to back pressure in said passage.

6. A gas turbine engine as claimed in any previous claim wherein the grooved face of said seal provides two lands which straddle the land in said upstream face of said disc, so as to provide the serpentine fluid flow path.

7. A gas turbine engine as claimed in any previous claim wherein the upstream face of the turbine disc has a pair of annular lands, one of which is straddled by the grooved face of the seal.

8. A gas turbine engine as claimed in claim 7 wherein one of said pair of annular lands comprises the position on the upstream face of said disc upon which the fluid under pressure impinges on exiting from said passage.

9. A gas turbine engine as claimed in any previous claim wherein the fluid under pressure is air compressed by the compressor of the gas turbine engine.

10. A gas turbine engine as claimed in any previous claim wherein the disc is a turbine disc.

11. A gas turbine engine as claimed in any previous claim wherein the disc is the most downstream compressor disc in a row of compressor disc.

12. A gas turbine engine substantially as described in this specification with reference to the drawings.

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